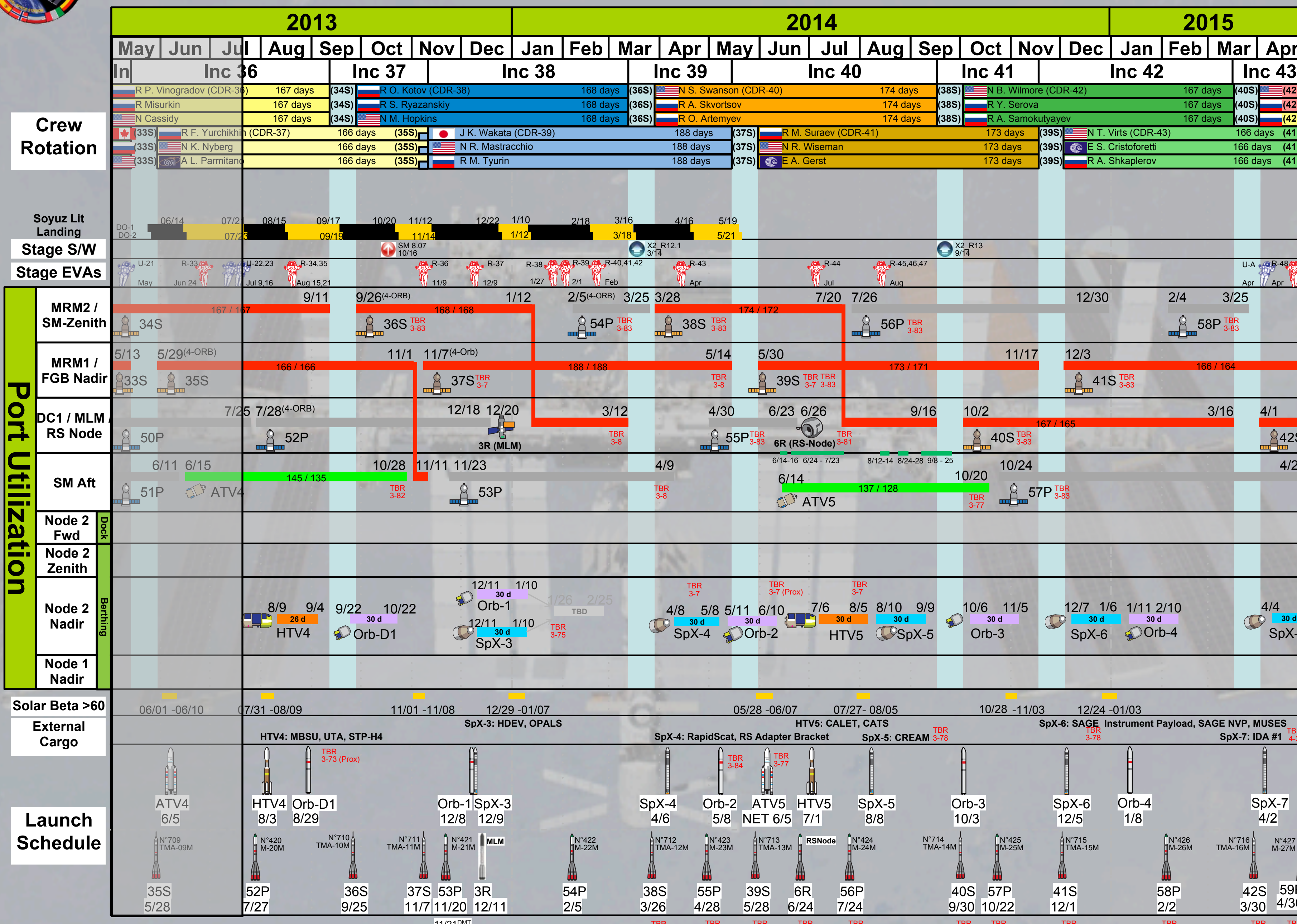
NAC Quarterly:
International Space Station Program Status

International Space Station
Program Overview

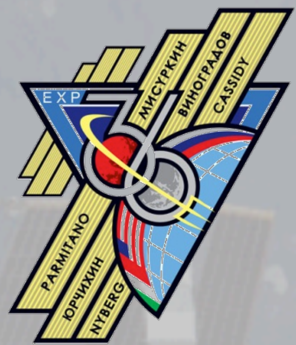
For current baseline refer to SSP 54100 Multi-Increment Planning Document (MIPD)

ISS Flight Plan

NASA: OC4/John Coggeshall
MAPI: OP/Randy Morgan
Chart Updated: July 17th, 2013
SSCN/CR: 13681B (Baseline)



35 Soyuz Launch/Expedition 36
May - November 2013



Vehicle: 35 Soyuz, TMA-09M

Launch: May 28, 2013

Docking: May 30, 2013

Undock/Landing: November 10, 2013

35 Soyuz Crew Expedition 36

Fyodor Yurchikhin Soyuz Commander & Exp 37 Commander
Karen Nyberg ISS Flight Engineer
Luca Parmitano (ESA) ISS Flight Engineer

Soyuz 35 crew will join crew already on orbit

Pavel Vinogradov Exp 36 Commander
Alexander Misurkin ISS Flight Engineer
Chris Cassidy ISS Flight Engineer

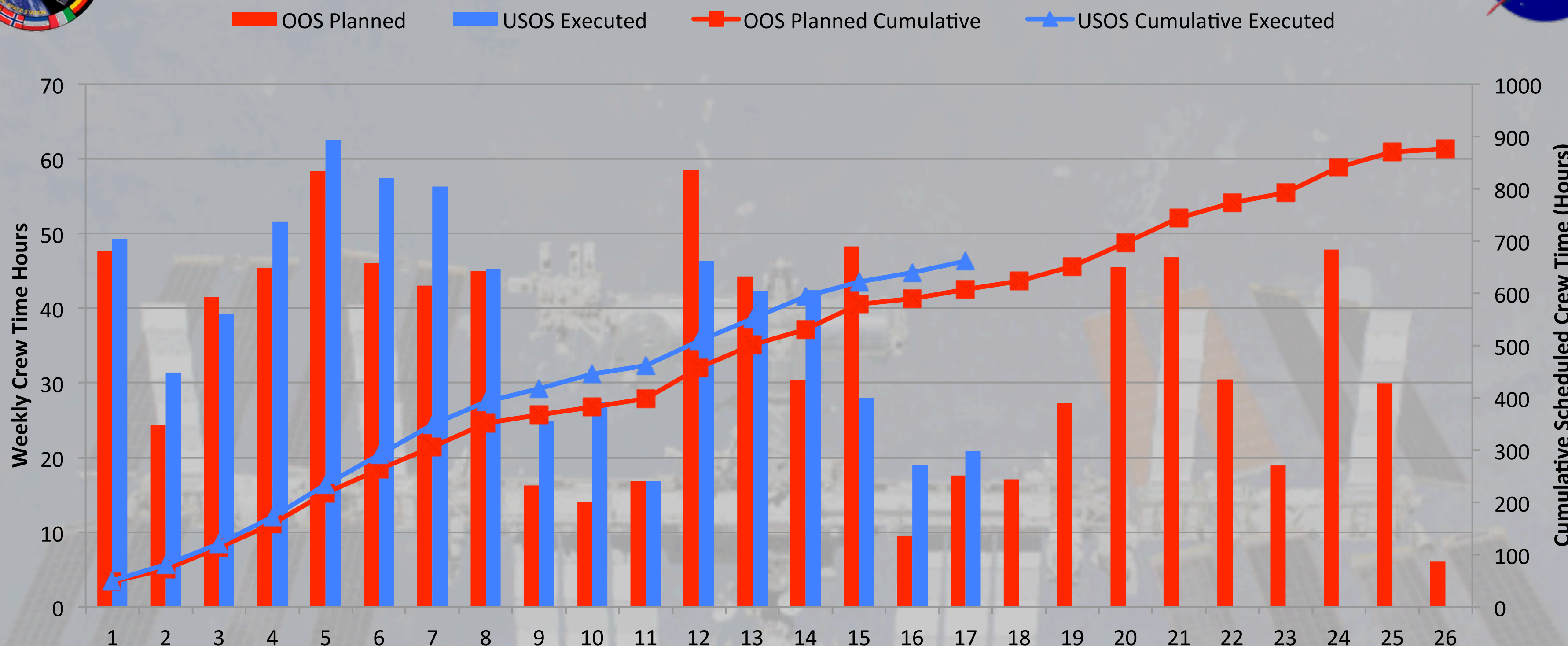
Expedition 36 Objectives
(May 2013– September 2013)

- Perform an average of 35 hrs/week for payload investigations. New investigations include:
  - **Skin-B** - *Studies the mechanisms of skin aging in microgravity . Will provide information on the mechanisms behind how skin adapts/ regenerates under the influence of weightlessness and the environmental conditions in spacecraft on long-duration missions, and will also provide a model for the adaptive processes of other organs in the body.*
  - **Space Pup** - *Studies the effects of space radiation on mammalian reproduction, which must be understood to sustain life beyond Earth. Freeze-dried mouse sperm will be kept aboard space station for one, 12, and 24 months, and then used to fertilize mouse eggs on Earth to produce mouse pups to study the effects of space radiation.*
  - **Stem Cells** - *Examines the effect of the space environment on the development of embryonic stem cells that have flown on the ISS. The cells are launched frozen and after returning to Earth are microinjected into mouse-8-cell embryos in order to analyze the influence of the space environment on the development and growth of adult mice.*
  - **Alloy Semiconductor** - *Studies how semiconductor materials grow and crystallize in microgravity. Will shed light on how higher quality crystals may be derived from other materials, or incorporated into other devices such as solar cells.*
  - **DIAPASON** - *Will test a simple instrument for studying nano-particle migration and capture achieved by very small thermal gradients. The particle size range of 2 nm to 1 micron will allow the monitoring of combustion-generated pollution, the analysis of hostile environments, and the identification of atmospheric contaminants.*
  - **ICE-GA** - *Collect data on the evaporation and combustion regimes of renewable liquid fuels which will be used to develop combustion models. These models will describe the behavior of new fuels which are key to selecting which class of fuels may be adopted in the future.*

- Support planned visiting vehicle traffic:
  - 35S docking, planned May 30
  - 51P undocking, planned June 11
  - ATV4 docking, planned June 15
  - Orb-D1 berthing, planned June 20
  - Orb-D1 unberthing, planned July 5
  - 50P undocking, planned July 21
  - 52P docking, planned July 26
  - HTV4 berthing, planned August 9
  - HTV4 unberthing, planned September 8
  - 34S undocking, planned September 11

- Significant tasks:
  - Perform RS EVA 33, planned June 26
    - R&R FGB thermal regulator, photo external RS MLI, Foton-Gamma removal
  - Perform USOS EVAs 21 and 22 in July
    - MLM Power & Ethernet cable routing, SGTRC-2 R&R, MISSE8 & ORMatE retrieval, RGB V-guides, Z1 Jumper install, R&R JEF Camera, FGB PDGF 1553 install
  - Perform RS EVA s34 and 35, planned in August
    - Route Power and Ethernet cable from FGB to MRM2, Setup portable workstation, two-axial targeting platform, medium resolution camera install
  - Install HTV4 delivered hardware

Inc 35-36 Utilization Crew Time

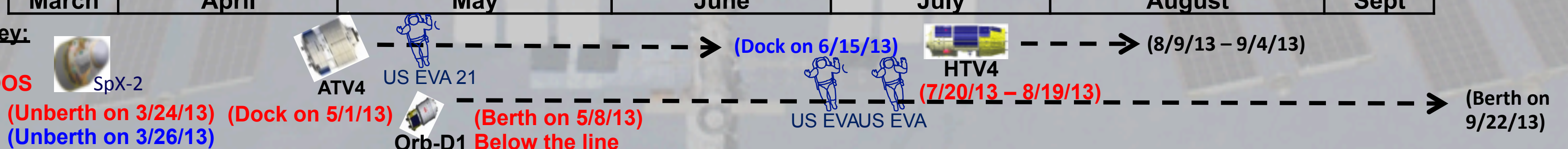


3-Crew | **6- Crew** | **3-Crew** | **6-Crew**

Increment 35 | **Increment 36**

March | **April** | **May** | **June** | **July** | **August** | **Sept**

Date Color Key:
Completed
35-36 Final OOS
FPIP Plan



WLP 2 contains 35 minutes of ESA Utilization that has not been agreed upon.

OC/OZ reconciliation is not completed as of Week 17.

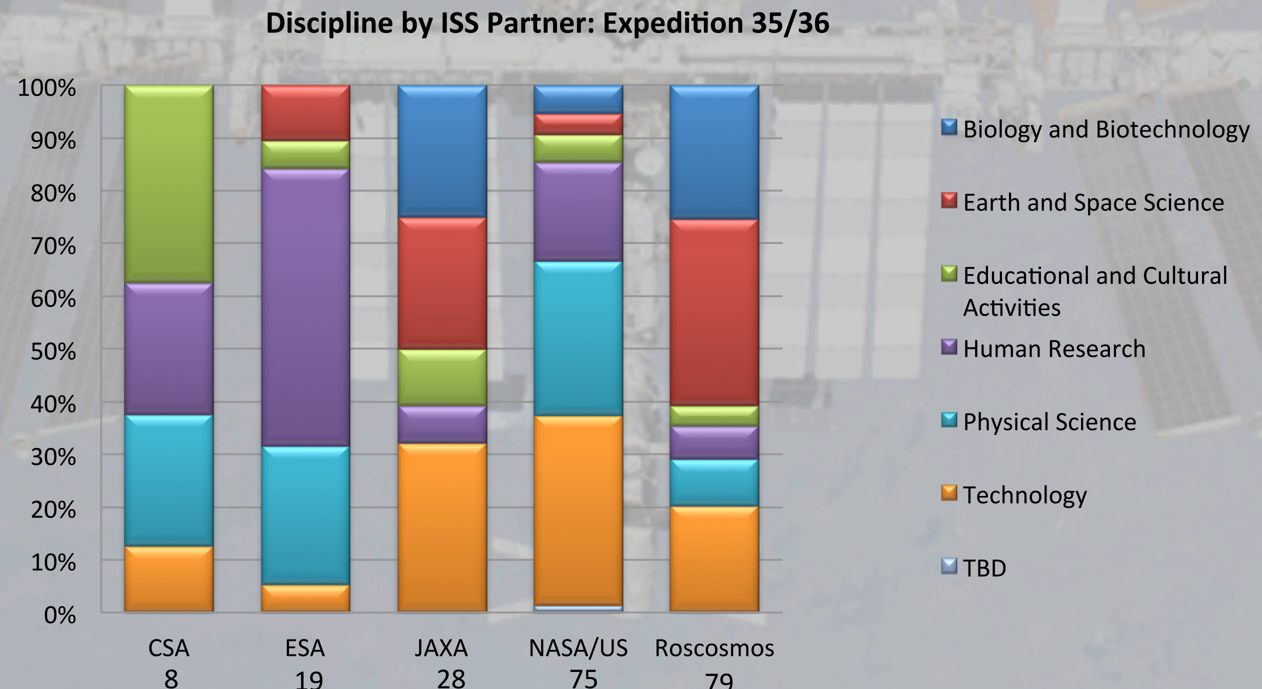
Executed through Increment Wk (WLP Week) 17 =	16.0	of 24.2 work weeks (66.12% though the Increment)
USOS IDRD Allocation:	875	hours
OOS USOS Planned Total:	876.49	hours
USOS Actuals:	661	hours
	75.54%	through IDRD Allocation
	75.41%	through OOS Planned Total
Total USOS Average Per Work Week:	41.31	hours/work week

ISS Research Statistics

Working data as of March 31, 2013

Number of ISS Investigations for 35/36 : 209

- 75 NASA/U.S.-led investigations
- 134 International-led investigations
- 30 new investigations
  - 1 CSA
  - 4 ESA
  - 7 JAXA
  - 16 NASA/U.S.
  - 2 Roscosmos
- Over 400 Investigators represented
- Over 500 scientific results publications (Exp 0 – present)



Number of Investigations Expedition 0-32: 1549

Total ISS Consumables Status: Total On-orbit Capability
28-June-13 HTV4/52P SORR, 52P (Dock 28-Jul-13)

	T1: Current Capability with no resupply		T2: Current Capability with 52P	
Consumable – based on current, ISS system status	Date to Reserve Level	Date to zero supplies	Date to Reserve Level	Date to zero supplies
Food – 100% (1) (2)	November 29, 2013	January 13, 2014	December 30, 2013	February 13, 2014
KTO	July 20, 2014	September 3, 2014	October 7, 2014	November 25, 2014 **(2)**
Filter Inserts	November 12, 2014	January 4, 2015 **(2)**	January 4, 2015	February 18, 2015
Toilet (ACY) Inserts (2)	June 21, 2014	August 5, 2014	July 16, 2014	August 30, 2014
EDV (UPA Operable) (2) (3) (4)	March 17, 2014	June 7, 2014	May 24, 2014	August 5, 2014
Consumable - based on system failure				
EDV (UPA Failed) (3)	December 31, 2013	February 14, 2014	February 23, 2014	April 17, 2014 **(2)**
Water, if no WPA (Ag & Iodinated) (2) (5)	December 15, 2013	January 29, 2014	January 25, 2014	March 11, 2014
O_2 if Elektron supporting 3 crew & no OGA (2) (6)	October 5, 2013	January 27, 2014	October 9, 2013	January 31, 2014
O_2 if neither Elektron or OGA (2) (6)	August 3, 2013	October 8, 2013	August 5, 2013	October 10, 2013
LiOH (7) (CDRAs and Vozdukh off)	~7 Days	~21 Days	~7 Days	~21 Days

(1) Includes food on Soyuz; after RS goes to zero, both sides share USOS food. **(2)** Reserve level to Zero is different than 45 days due to varying crew size. **(3)** Progress tanks included in assessment for urine dumping only. **(4)** A-RFTA operations as of 8/6/12. Assumes 75% recovery rate and no RS urine processing. **(5)** RS processes all condensate in event of WPA failure. **(6)** Includes metabolic O2 for 45 day/6-crew reserve and the O2 for greater of CHeCs or 4 contingency EVAs. **(7)** LiOH Canisters will be used for CO2 removal from the ISS if the CDRAs are inoperable. Total LiOH Reserve Level is 14 days for 6 crew. (Reserve Level for USOS LiOH is ~13.3 days for 3 crew (20 canisters), and for RS LiOH is 15 days for 3 crew (15 canisters).)

USOS System Challenges

- **2B Photo-Voltaic Thermal Control System (PVTCS) Leak Status – In work**
  - On May 9th, the crew has reported visible white flakes in window views floating away from ISS on the port side of the vehicle. Telemetry indicated the 2B PVTCS ammonia quantity was dropping. On 5/10, the PVTCS loop and 2B power channel output were shutdown. 2B channel electrical loads were power seamlessed to 2A, with 2A supporting both 2B and 2A electrical loads.
  - On May 10th, the crew performed an EVA to troubleshoot the lead. They translated to the P6 truss and removed and inspected the 2B Pump Flow Control System (PFCS). No ice or foreign material was reported. Nothing appeared anomalous with the removed PFCS. Imagery was taken for ground analysis. It was replaced with a spare from the legacy Early External Thermal Control System (EETCS) system. The failed PFCS was stowed in the spare's original location. While the crew was still within viewing distance of the area, the newly installed pump was activated. They reported that there was no evidence of leakage.
  - Channel 2B with the newly installed PFCS is currently showing no signs of a gross leak. Long-term trending is necessary to confirm whether the previously observed slow leak has been abated too. Telemetry from the old PFCS removed and replaced in the spare location showed the leak was present in the pump supporting that it was the source of the leak that began on May 9th.
  - 2B electrical loads were transferred from 2A back to 2B and all DDCU share ratios have returned to nominal 50/50.

USOS System Challenges

- **51P Docking Issue**
  - The Progress 51P Kurs-A antenna ACΦ2 failed to deploy nominally. All attempts by MCC-M to deploy the antenna had been unsuccessful. MCC-M worked out a plan to dock Progress to the SM AFT docking port with the antenna in the stowed configuration. All other Progress systems were performing nominally. 51P successfully docked to the ISS Russian Segment Service Module (SM) aft port. All Progress systems operated nominally with the exception of Kurs ACΦ2 antenna which had still not deployed. A software patch was uplinked to the 51P vehicle which allowed the automated rendezvous using only one deployed antenna and extended the final approach time from 11 to 20 minutes. Kurs-A antenna fully deployed after Progress undocking from the ISS. No damage to the ATV Laser Retro Reflector assemblies were detected. ATV4 docked nominally a few days later.

- **Ku-Band Antenna Group 2 (AG2) Forward Link Anomly – Waiting for R&R**
  - On GMT 351, the Ku-band Group 2 failed to acquire TDRS. The Ku-band was configured to open loop pointing, with success in acquiring the return link, but not the forward link. Ku-band swapped to Antenna Group 1, acquiring TDRS nominally. Antenna Group 2 is currently powered off, with heaters enabled. Root cause identified a suspect failure in the Space to Ground Transmitter Receiver Controller (SGTRC). A spare SGTRC is available on-board. Removal and replacement was completed during US EVA #22 in July 9, 2013. SGTRC checkout was successful.

USOS System Challenges

- **HTV3 Abort**
  - The HTV3 abort was caused by an interaction between the grapple fixture cam arms on the vehicle and the initial motion of the SSRMS during back away due to the relative positions of the HTV and the ISS. This interaction created rates on the HTV vehicle that, when checked on board the HTV, indicated the HTV would leave its designed departure corridor and thus it initiated an abort per joint safety requirements.
  - No damage was done to the ISS. NASA has assessed a number of options to eliminate this interaction to mitigate risk of an abort on future vehicles and is implementing a modified SSRMS release approach to incorporate a delay in the start of initial SSRMS back away. Implementation is on schedule and includes refining visual cues for the crew to monitor the release as well as potentially adjusting SSRMS configuration parameters to provide a smooth separation between the SSRMS and the vehicle.
  - NASA has assessed other free flyer vehicles (Dragon and Cygnus) and has implemented a corresponding approach to mitigate the concern.

- **HTV4 Abort challenge and mitigation**
  - ISS Yaw Attitude for capture and ISS pitch attitude for release sufficiently mitigate or eliminate any potential for main engine abort plume damage to ISS structure
  - All NASA and JAXA organizations have identified the analysis required to support a -11 degree ISS yaw attitude for HTV-4 rendezvous
  - All NASA and JAXA organizations have assessed the integrated schedule and confirmed the analysis can be completed in time to support an August 3rd HTV-4 launch date
  - Russians have cleared Progress, Soyuz, and Service Module (SM) array loads
  - Working to clear Progress, Soyuz, and SM array heating
  - Working to coordinate ATV array feathering
  - Closure of open work supports resolution of IRMA Risk 6445, Qualification Table, and COFR Exception
  - Delta Stage Operations Readiness Review planned for 7/25

USOS System Enhancements

- **Carbon Dioxide Removal Assembly (CDRA) "-4" Desiccant/Adsorbent Beds-Monitoring**
  - Two new CDRA beds was launched on SpX-2
  - New features include a redesigned heater core with significantly thicker Kapton insulation to reduce risk of short, and completely re-engineered attachment points to the wiring harness to reduce strain at the wiring interface
  - New beds have been manufactured under clean-room conditions to reduce chance for built-in FOD
  - Sheets for the heater core have been re-engineered to reduce sharp edges and weld points which were potential FOD sources from welding slag
  - Beds incorporate new temperature sensors which have been changed from a thin-film sandwich type to a completely new helical wire-wound construction, significantly improving sensor survivability under repeated thermal cycles (similar to commercial applications in aircraft brakes)
  - Shape of the desiccant and absorbent materials were changed to allow for more efficient packing on the ground and to potentially reduce dusting due to material abrasion when exposed to long term thermal/vacuum cycles on-orbit
  - Housing of the bed was updated to accommodate the addition of captive fasteners and other features to allow the crew to partially disassemble the adsorbent bed on-orbit to remove the dust that accumulates from operation of the CDRA without having to return the beds to the ground for refurbishment

EVA 23 EMU 3011 Internal Water Leakage

- On 7/16/13, EV2/Luca Parmitano reported feeling water in his helmet at about 45 minutes into US EVA 23. Later in the EVA, EV1/Chris Cassidy confirmed a large amount of water inside the helmet. The crew were able to get EV2's helmet off and he was found to be in good health.

- Initial troubleshooting was executed on 7/17/13. It was determined that an estimated 1.8 lbs. of re-supplied feedwater was unaccounted for beyond nominal EVA usage, which is consistent with the crew reports of approximately 1.0-1.5 liters in the helmet by the end of the EVA. The Disposable In Suit Drink Bag (DIDB) was filled, folded and squeezed with no leaks. There were no leaks reported in the Liquid Cooling and Ventilation Garment (LCVG) and other water lines inside the Hard Upper Torso (HUT).
- .

EVA 23 EMU 3011 Internal Water Leakage

- As a result of the troubleshooting, the most likely path of the water leak is through the helmet vent port. The remaining credible failure sources are located in the EMU Portable Life Support System (PLSS).
- The technical, operational and safety community have revised the fault tree based on a thorough review of safety documentation, an understanding of the design of the suit and through observed operational behavior. A formal fault tree closure process is being defined.
- Additional troubleshooting is planned for 7/26/13. The goal of this troubleshooting is to gather data that will be used to close out legs of the fault tree. Additional team meetings will convene to discuss further troubleshooting and recovery options, as required.
- The community is reassessing the safety documentation and operational procedures to insure that sufficient controls exist to mitigate the internal water leakage should an event such as that seen during EVA 23 recur.

USOS System Enhancements

- **Continue replacement of legacy ISS avionics with Obsolescence Driven Avionics Replacement (ODAR) components**
  - Integrated Communications Unit (ICU) activated - doubling the downlink data rate (300 Mbps) and an eight-fold increase in the uplink data rate (25 Mbps)
  - improved Payload Ethernet Hub Gateway (iPEHG) ready for activation in late May – tenfold increase in medium rate onboard data communications (100 Mbps)
  - 2 additional SIG cahnnels added: space to ground 3 & space to ground 4
  - 6 video channels down versus 4 with original system
  - 2 flight ICUs and 4 iPEHGs are on-orbit; 3rd flight ICU planned for launch on ATV4
  - iPEHG installation occurred May 3, 2013

USOS System Enhancements

- In an effort to increase the utilization of Commercial off the Shelf (COTS) hardware with limited or no modifications to support on-orbit operations, the ISS Program worked with commercial industry to develop a power inverter which converts the DC power generated from the ISS solar arrays to AC power just as you would find in your home.
- The provision of AC power allows ISS systems and payload developers to simplify and reduce the schedule and cost for the development, integration and delivery hardware into the ISS.
- The ISS power inverter (pictured below) comes in two models: 120Vdc-to120Vac and 28Vdc-to-120Vac respectively to support the primary power input voltages provided throughout the ISS (USOS and Russian Segments) and payload power interfaces.
- The 120Vdc-to120Vac power inverter provides power AC power provides: four (4) standard three prong AC power outlets and is capable of providing a total of 750W @ 60hz.
- The 28Vdc-to120Vac power inverter provides power AC power provides: four (4) standard three prong AC power outlets and is capable of providing a total of 400W @ 60hz.
- Russians are working on certification for use in the Russian segment

Road to Orbital Demo Mission

- **Status**
  - Flight Operations Review (FOR) completed
    - Continuing monthly Joint Multi Segment Trainings (JMSTs) to keep ops teams proficient
  - Post Qualification Review (PQR) completed
  - Safety Review Panel (SRP) Phase III is complete
    - All remaining open work has been moved to the Safety Verification Tracking List (SVTL)
  - Joint Software (SW) Stage Testing has been completed
  - Cygnus is fueled and cargo is loaded
    - Late load cargo will be loaded about L-8 days
  - Antares Launch Vehicle (LV) integration proceeding in the Horizontal Integration Facility (HIF)
    - Engine 9 (E9) and E12 are paired for this mission and are both at Wallops Flight Facility (WFF) integrated on thrust frame
- **Milestones**
  - ISS Orb-D Vehicle Assessment Review (VAR) on 5/2
  - Orbital Orb-D Mission Readiness Review (MRR) on 6/26
  - ISS Stage Operations Readiness Review (SORR) on 7/8
  - Orbital NET readiness is 8/29

Test Flight of Antares rocket on 4/21 from WFF

Photo Credit: Orbital

SpaceX-3 Mission Status

- **Pressurized cargo (Expecting full launch/return complement of 1580kgs, 3476 lbs)**
  - Powered Middeck Lockers:
    - ***Launch***: 1 GLACIER ; Micro-7 and Biotube Micro; 2 MERLINs
    - ***Return***: 2 GLACIERs ; Micro-7 and Biotube Micro Experiments
  - 5-6 Cold Bags
  - Launching a T-Cell experiment used to test the immune system
- **External Cargo**
  - High Definition Earth Viewing (HDEV) Camera on NASA Columbus External Payloads Adapter (CEPA) and Optical PAyload for Lasercomm Science (OPALS) on SpX Express Payload Adapter (ExPA) (first use of SpX built ExPA)
  - Poly-Picosatellite Orbital Deployer (P-POD) is secondary payload
- **Dragon 5 Status**
  - Monitoring cargo interface environment changes as a result of Falcon 9 and Dragon vehicle upgrades
  - Dragon to ISS Ethernet Technical Interchange Meeting (TIM) was conducted in May
  - Ground processing TIM for Press/Unpress payloads was held from 5/21 – 5/23
  - Cargo rack installation was completed on 5/31
  - Service Section avionics installation is planned in Jul
  - Capsule to Trunk stack planned for 8/16 for integrated checkouts
  - Cargo Integration Review (CIR) planned for Aug
  - Ship to Cape planned for 9/30 (Trunk) and 10/2 (Capsule)
- **F9v1.1 Status**
  - New Falcon 9 version 1.1 (F9v1.1) is undergoing qualification testing currently and will be utilized on the SpX-3 mission. Two to three commercial flights including the test flight are planned prior to use of the new launch vehicle configuration for the SpX-3 flight. The F9v1.1 rocket is planned to increase the upmass capability from 800 kg to 1580 kg of cargo.

Falcon 9v1.1 Stage 1 testing at McGregor, TX

Photo Credits: SpaceX

International Space Station
International Partner Flights

ATV4 Mission Status

- **Successfully Launched on 6/5 and docked on 6/15, unberth planned 10/28**
- **Cargo**
    - Manifest (in kg): ~2580 kg prop for ISS use, 860 kg prop for transfer, 100 kg (air and O2), 570 kg water, and ~2479 kg packed dry cargo
    - Key cargo includes:
        - JAXA Multi-Global Positioning System (GPS) Antenna Bracket and four payload experiments
        - ESA Columbus Water Pump Assembly (WPA) , Flight Crew Equipment (FCE) toolkit, and three payload experiments
        - U.S. Integrated Communications Unit (ICU), Pump Separator, eight payload experiments, eight flight crew equipment items, computer items, Extravehicular Activity (EVA) equipment, Crew Health Care System (CHeCS) hardware and crew supplies
- **Status**
    - Failures detected on the way to ISS (lost gyro, communication loss on string 2, and jet failure that took Propulsion Drive Electronics (PDE) #4 offline) have been determined to have no effect on docked ops or undock/re-entry
        - Plan in place to recover lost gyro with a reset of ATV computer during docked operations, no specific date set
        - Plan to re-integrate PDE 4 on July 8. ESA is investigating the ability to re-integrate the jet
        - Utilizing other communication string options to get solid commanding via Tracking and Data Relay Satellite (TDRS) to ATV4

Albert Einstein (ATV4) being prepared for launch

Photo Credits: ESA

HTV4 Mission Status

- **Cargo – (Manifest Requests (MRs) pending)**
  - ~3144 kg currently manifested for ISS
    - 2257 kg of pressurized cargo, including crew supplies and computer resources (582 kg), water bags and flight support equipment (571 kg), vehicle hardware (676 kg), utilization hardware (357 kg), Extravehicular Activity (EVA) supplies (71 kg), and
    - 887 kg of unpressurized cargo
  - External cargo includes:
    - Space Test Program – Houston 4 (STP-H4)
    - Main Bus Switching Unit (MBSU)
    - Utility Transfer Assembly (UTA)
    - For disposal: Space Test Program – Houston 3 (STP-H3)
- **Status**
  - All HTV modules have been integrated and testing of the integrated vehicle is on-going
  - Qualification Technical Integration Meeting (TIM) is planned in Jul
    - The use of the main engines in close proximity to the ISS can exceed plume loads and thermal requirements; ISS Program is evaluating options to eliminate the effects of the main engine abort
  - Initial late load begins at L-13d. Final late load occurs at L-3d
  - Launch planned on 8/3 (GMT), 8/4 Central
  - Berth planned on 8/9
  - Unberth planned on 9/4

HTV3 on approach to ISS

HTV3 launch from Tanegashima Space Center

Photo Credits: JAXA/NASA